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(54) **A fermentation plant for producing gas from organic matter, such as manure**

(57) A fermentation plant for producing gas from manure or other organic matter comprises a tank (10) for the matter (13) to be fermented, the tank being covered by an elastic membrane roof (16) comprising a carrying network (26) of straps of synthetic resin, and on top thereof a heat insulating and elastically deformable cover of insulating material (31) securely attached to the outward face of the wall of the tank, so no gas can leak out.

FIG. 1

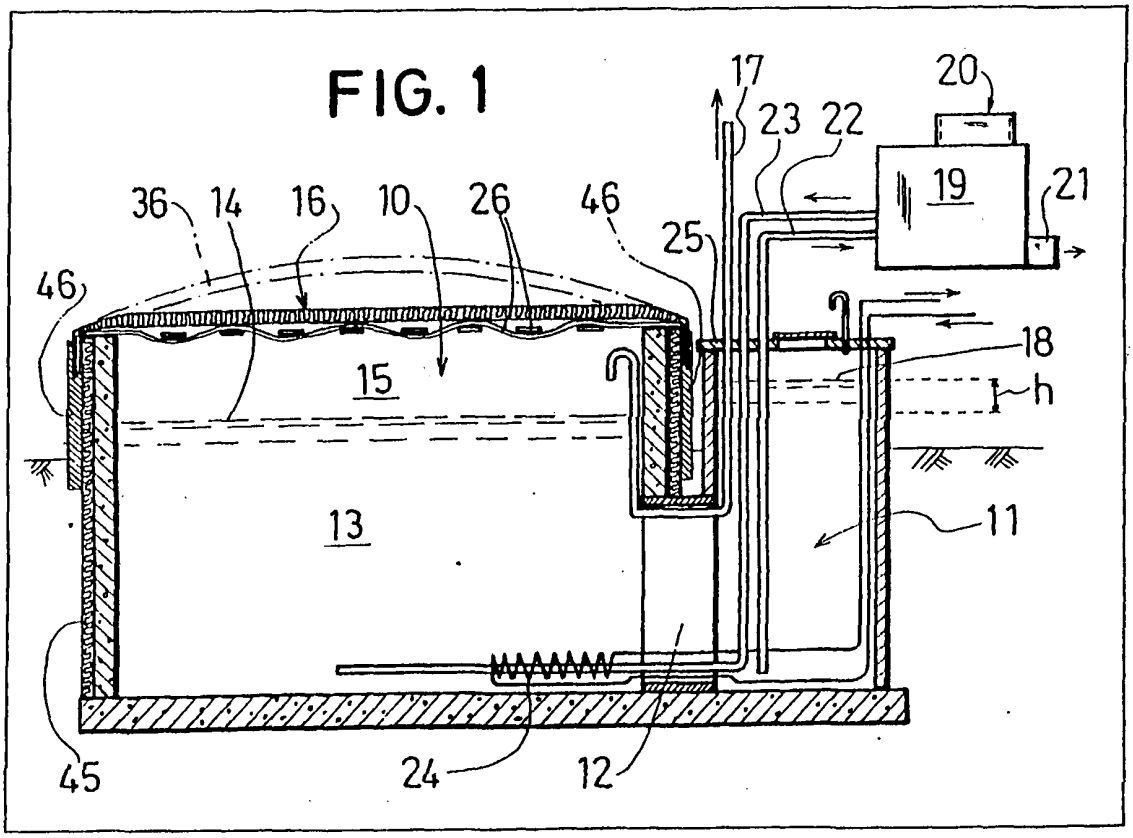

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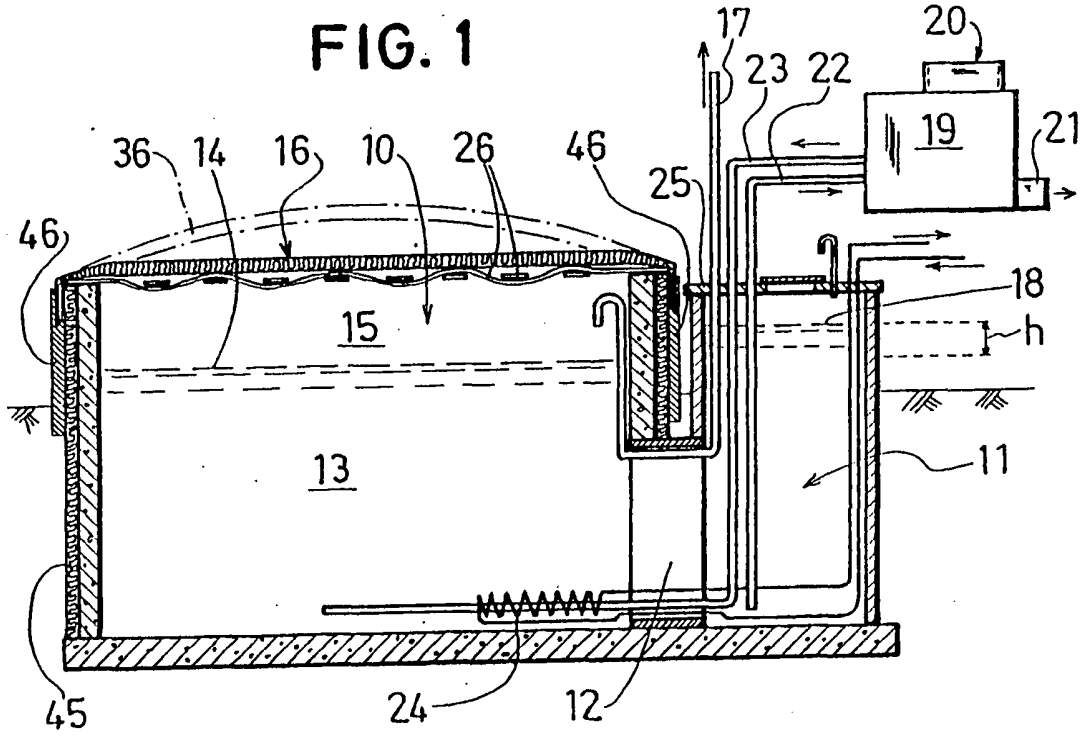
FIG. 1


17
20
23
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16
10
26
46
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46
18
15
h
13
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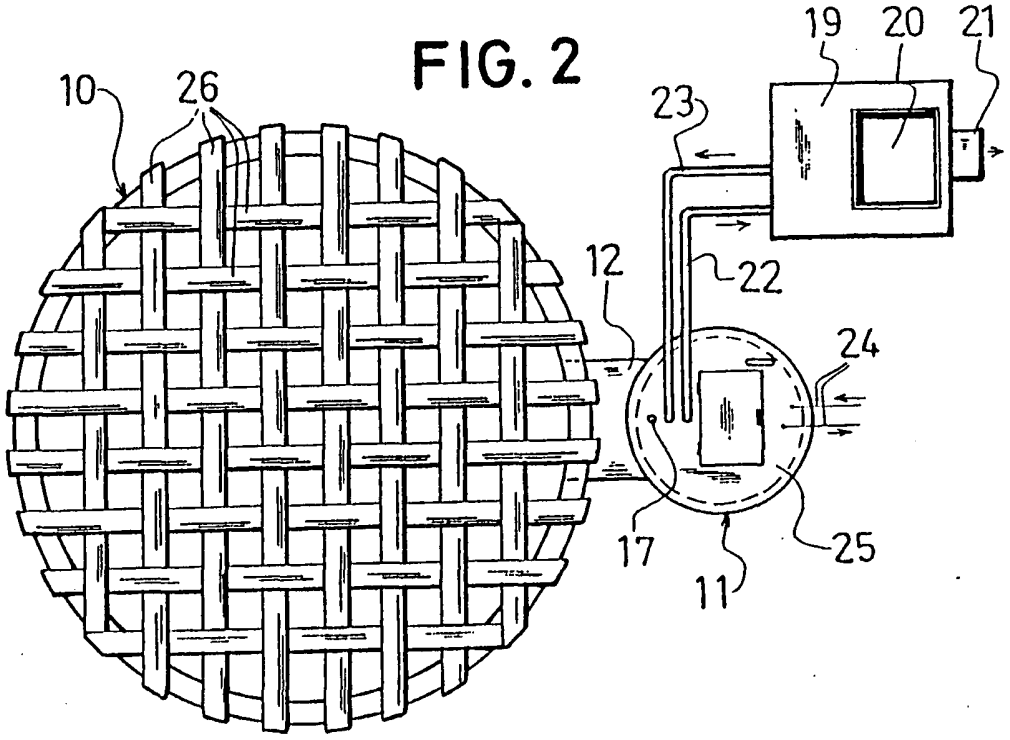
45
24
12

FIG. 2


19
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26
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17
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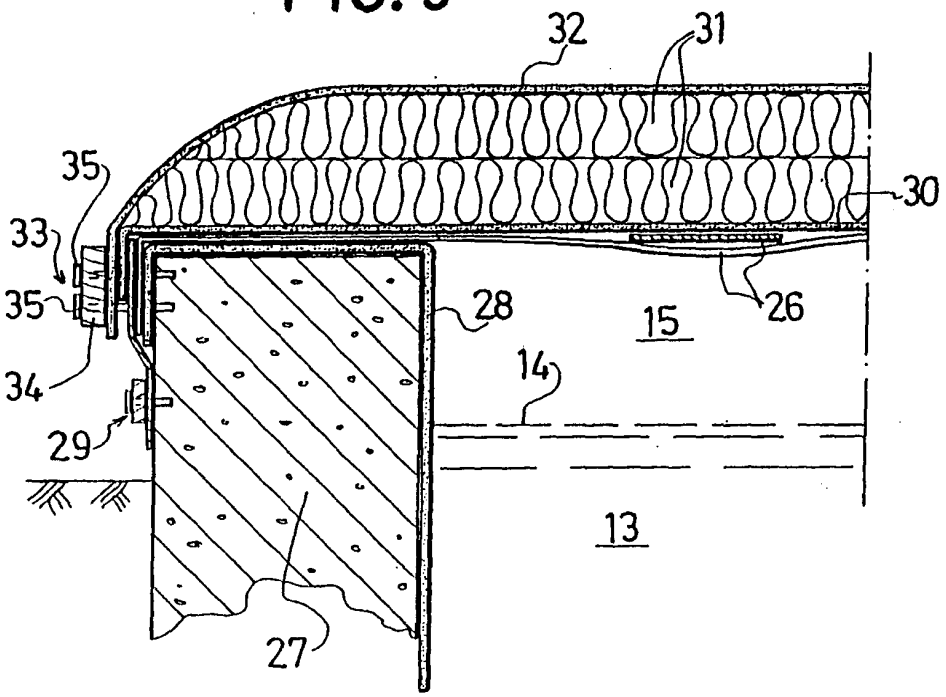
FIG. 3


32
31
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33
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28
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26
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14
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13
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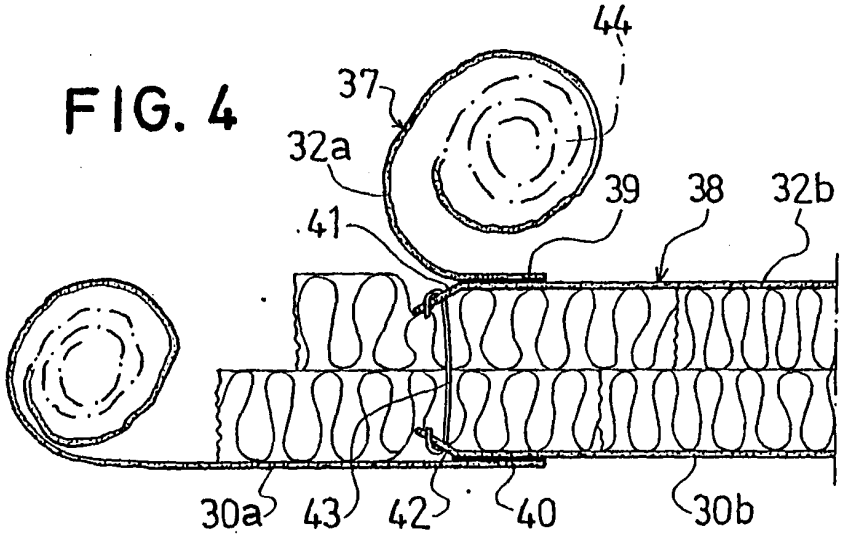
FIG. 4


44
37
32a
39
38
32b
41
30a
43
42
40
30b

SPECIFICATION

A fermentation plant for producing gas from organic matter, such as manure

This invention relates to a fermentation plant for producing gas from organic matter such as manure.

Manure from domestic animals, as well as other organic matter, can advantageously be used for producing gas suitable as fuel for combustion in furnaces and/or in internal combustion engines.

The problems to be solved are to maintain a low investment level, to collect the gas, to introduce the organic matter into a fermentation tank, and to remove it therefrom without appreciable loss of gas.

At a farm of the size making it attractive for gas production, there is usually a basin for collecting manure.

Proposals for making possible the use of such a basin as a fermentation tank have been made, but have presupposed the use of heavy, rigid rooves through which gas conveying conduits have extended. Such solutions are, however, expensive and there are sealing problems.

An object of the present invention is to provide a fermentation plant with a simple and rational cover for the tank holding the organic matter, such as manure, to be fermented, which will involve low investment costs and ensures a safe operation with limited gas losses.

A fermentation plant according to the invention comprises a fermentation tank for the organic matter, and elastic roof for covering the tank, means for supplying organic matter to the tank and withdrawing fermented residues therefrom, and a conduit for withdrawing gas.

The invention is characterized in that the roof comprises an open-work carrying structure of strands and/or ropes stretched over the top of the tank, and an insulating layer supported freely thereby, the structure and the layer being both secured to the outside of the wall of the tank.

The insulating layer preferably comprises a top and a bottom gas-tight sheet, which between themselves enclose blankets of insulating material.

The carrying structure is preferably attached to the tank wall by means located below an upper edge of the wall, and marginal portions of the upper and lower sheets are gas-tightly secured to the tank wall by means located higher up along the tank wall, than the means securing the carrying structure. An upper part of the tank wall is preferably covered by a gas-tight sheet extending over the upper edge of the tank wall and hanging down along an inner face of the wall, to a position below a normal operating level of organic matter within the tank.

When the material in the sheets is subdivided into gores extending over the tank the gores may overlap along their longitudinal edges. At a longitudinal joint, edges of an upper and a lower gore may extend past the edges of the meeting gores to be permanently bonded thereto by seams running a distance inside of the edges of last-mentioned gores, whereby free marginal portions will be formed inside of the continuous upper and lower sheets. The free marginal portions are then sewn together through the insulating material.

The invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a section through a fermentation plant for producing gas constructed according to the present invention,

Figure 2 shows the plant, as viewed from above, with part of a roof thereof removed,

Figure 3 shows on a larger scale, a detail of the attachments for the roof at the tank wall, and

Figure 4 shows a detail of the roof during the fitting thereof.

In Figure 1 the fermentation tank is deonted by 10 and is, in the manner common with manure basins at farms, partly recessed into the ground. Basins of this type may be designed with different cross-sections, but are often circular to facilitate construction. A well 11 is sunk at a short distance from the basin. The well is dimensioned to permit access thereto and to contain equipment of the kind to be described herebelow. The basin and the well communicate by way of a passage 12, which is wide enough to permit a person to crawl through. During operation, the basin and the well are filled with fermenting matter 13, which must not rise above a level 14 within the basin, thus leaving a space 15 thereabove for collecting gas.

The basin is covered by a roof 16, which will be described in detail herebelow, and it is essential that the basin is fully closed upwardly. Gas is tapped-off by means of a conduit 17, which extends from the gas collecting space 15 within the basin, by way of a U-formed portion, through passage 12 and up through the well 11, to be connected to an arbitrary consumer. Advantageously some kind of gas storage vessel will be provided, but is not shown in the drawings.

The basin and the well will operate as communicating tubes, and when there is a gas pressure in space 15 the level 18 for the matter within the well will rise above the level 14 within the basin. It is therefore important that the well has such a height that the matter within the well, in spite of expected difference 'h' between the two levels, will not spill over the edge of the well. The amount of matter contained in the two communicating tubes may be controlled in any suitable manner, which need not be described in detail.

The operation of the plant will be simplified if the manure is in the liquid state, and Figure 1 indicates very schematically a device 19 for transferring manure.It is presupposed that fresh manure is introduced at 20, and that the fermented residue is withdrawn at 21. The fermentation process is promoted by the fermenting matter being stirred, which in this example is brought about by a portion of the liquid matter being withdrawn through a conduit 22, and then pumped back through a further conduit 23. The latter conduit is terminated by a nozzle adacent to the bottom of the basin, which will maintain a continuous movement within the bulk of fermenting matter. Heat may possibly be added by means of a heating coil 24. The well is closed by a cover 25, but

it is not necessary to provide any sealing. The volume of gas produced in the well is insignificant, and may be permitted to leak away.

The important feature of the invention is, as mentioned earlier, the roof 16 covering the fermentation tank 10. The roof must be of light weight and be manufactured from materials, which can withstand the atmosphere in the tank, and furthermore must be able to adjust itself to variations in pressure, which occur from time to time, without the risk of gas leakage.

Figure 2 shows how a network 26 of straps of synthetic resin, for instance butylene rubber, and reinforced in any suitable manner, are stretched over the edge of the basin wall. Instead of straps, ropes may be used. The strands are attached to the outside of the basin wall in the manner to be described in connection with Figure 3, and will form a carrying structure for a gas-tight cover, which will be subjected to the pressure of the gas through the meshes in the network 26.

Figure 3 shows a portion 27 of the upper part of basin wall. A sheet of butylene fabric 28 is draped over the wall, to cover the top thereof and hanging down along the inward face thereof, somewhat below the normal level 14 of the manure in the tank. The gas within chamber 15 has, thus, no possibility to penetrate the basin wall. As described earlier, the strands, or ropes of the supporting structure 26 are extended over the top of the wall, and are attached to the outside of the walls by suitable means 29 located some distance below the upper edge of the wall.

The cover proper of roof 16 comprises a lower sheet of gas-tight fabric 30, preferably some butylene material, insulating blankets 31, and an outer, reinforced synthetic resin fabric 32, for instance some PVC-plastics. Both sheets are extended down along the outer face of the basin wall, and are secured thereto by means 33, including a bar 34 extending continuously around the basin, and a number of bolts 35 for forcing the bar against the wall. The bolts 35 may easily be located between the downwardly extending ends of the straps, or ropes, in the carrying structure 26. When gas is formed, the pressure within space 15 will rise, as mentioned before, and the cover 16 will then be expanded outwardly, as is deonted by broken lines at 36 in Figure 1. When the gas pressure is reduced, for instance, during an exchange of the matter contained in the tank, the cover will collapse to rest upon the structure 26.

With large roofs it is not possible to provide continuous base sheets and insulating carpets of sufficient size, so it will be necessary to work with gores, which extend one way over the basin, and which in some suitable manner are interconnected. The sheets 30, 32 are supplied in gores with standardized breadth, and it will be possible to weld a number of such gores together to a sheet of sufficient size completely to cover the basin. The insulating material 31 may be delivered in lengths or slabs of a certain breadth. A connection between the gores of fabric may preferably be formed in the manner illustrated in Figure 4, before the covering of the basin starts.

When the gas-tight cover is to be fitted upon the carrying structure 26, the sheets are rolled together with the joints between the gores parallel to the longitudinal axis of the rolls formed. First sheet 30 is placed on the supporting structure and one end thereof is attached to the basin wall. Then insulating material 31 is fitted in place, to and past the first gore joint. Preferably the bottom sheet is not rolled out far beyond the first gore joint, as this will make it easier to complete the joint. Finally the top sheet 32 is rolled out to the joint and the two sheets and the insulating material are secured together.

Figure 4 shows a preferred way of securing the materials, it being supposed that the work proceeds from the right towards the left. The sheet portions 30*a* and 32*a* in "later" gores 37 overlap preceding gores 38, and extend outside of sheet portions 30*b*, 32*b*. They are welded, vulcanized or in some other manner permanently joined thereto by seams 39, 40 extending a distance inside of the longitudinal edges of the "preceding" portions.

The gores 38 will in this manner show free margins 41, 42, which may be provided with openings, reinforced by eylets. These marginal portions may be sewn or tied together by strings 43, which by a suitable needle are forced through the insulating material and the eyelets. Mineral wool is preferably used as insulating material and may be provided in two layers, wherein care is taken that laps between slaps or carpets in the two layers will occur in staggered positions. The standard breadth of insulating material is often less than the breadth of the fabric gores. During the mounting there is no difficulty in folding the edge of the insulating material, so the lower marginal portion 42 of the bottom sheet will become available.

Reference 44 denotes how the remainder of the roll of top sheet 32 rests upon the insulating material during the sewing operation. In this manner there will be no sewn joints in the inwardly or downwardly faces of the fabric sheets, which could cause gas leakage, but a satisfactory retention between the sheets and the insulating material is still obtained.

The fermentation tank may be based upon the manure basin of a farm, but can evidently be constructed specially for the production of gas. The organic matter may be manure of different kinds, which is, or may be transferred into, a fluid suitable for pumping. This provides for simple handling within the communicating spaces formed by the basin and the well.

The fermentation tank 10 may be insulated first by ground insulation 45 and outside the part thereof extending above ground level by a weather-resistant layer 46. In order to obtain a satisfactory sealing against gas leakage, the lower sheet 30 may be cut to fit the outer contour of the basin wall. A vertical skirt, hanging down along the outside of the wall is then vulcanized along the perimeter of the cut sheet. In this manner the folds are avoided, which will easily occur when too large a sheet is folded over the wall edge. A strip of soft material may be provided between the bar 34 and the layers of sheet fabric underneath, so an efficient pressure may be applied.

It is not necessary to arrange the strands in the carrying structure in any regular, crosswise pattern. However, some strands may be extended diagonally across the tank, so that like spokes in a wheel they meet at the center of the tank.

CLAIMS:

1. A fermentation plant for producing gas from organic matter, such as manure, and comprising a fermentation tank for the organic matter, an elastic roof for covering the tank, means for supplying organic matter to the tank and withdrawing fermented residues therefrom, and a conduit for withdrawing gas, characterised in that the roof comprises an open-work carrying structure of strands and/or ropes stretched over the top of the tank, and an insulating layer supported freely thereby, the structure and the layer being both secured to the outside of the wall of the tank.

2. A plant as claimed in claim 1, characterised in that the insulating layer comprises a top and a bottom gas-tight sheet, which between themselves enclose blankets of insulating material.

3. A plant as claimed in claim 1 or claim 2, characterised in that the carrying structure is attached to the tank wall by means located below an upper edge of the wall, and that marginal portions of the upper and lower sheets are gas-tightly secured to the tank wall by means located higher up along the tank wall, than the means securing the carrying structure.

4. A plant as claimed in any of the preceding claims, characterised in that an upper part of the tank wall is covered by a gas-tight sheet extending over the upper edge of the tank wall and hanging down along an inner face of the wall, to a position below a normal operating level of organic matter within the tank.

5. A plant as claimed in any one of claims 2-4, where the material in the sheets is subdivided into gores extending over the tank, characterised in that the gores overlap along their longitudinal edges, and in that at a longitudinal joint the edges of an upper and a lower gore extend past the edges of the meeting gores and are permanently bonded thereto by seams running a distance inside of the edges of last-mentioned gores, whereby free marginal portions will be formed inside of the continuous upper and lower sheets, said free marginal portions being sewn together through the insulating material.

6. A fermentation plant for producing gas from organic matters, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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